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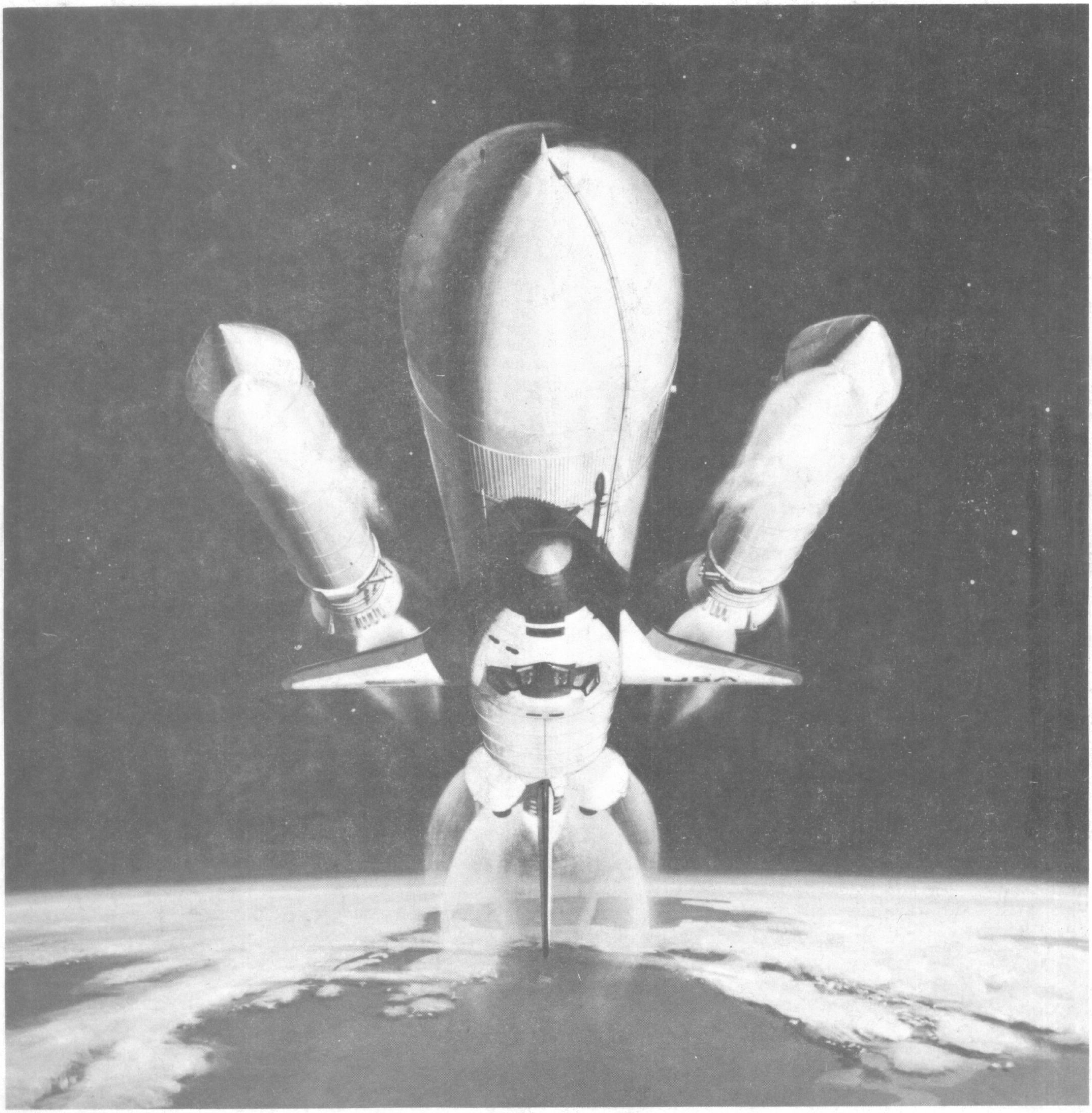
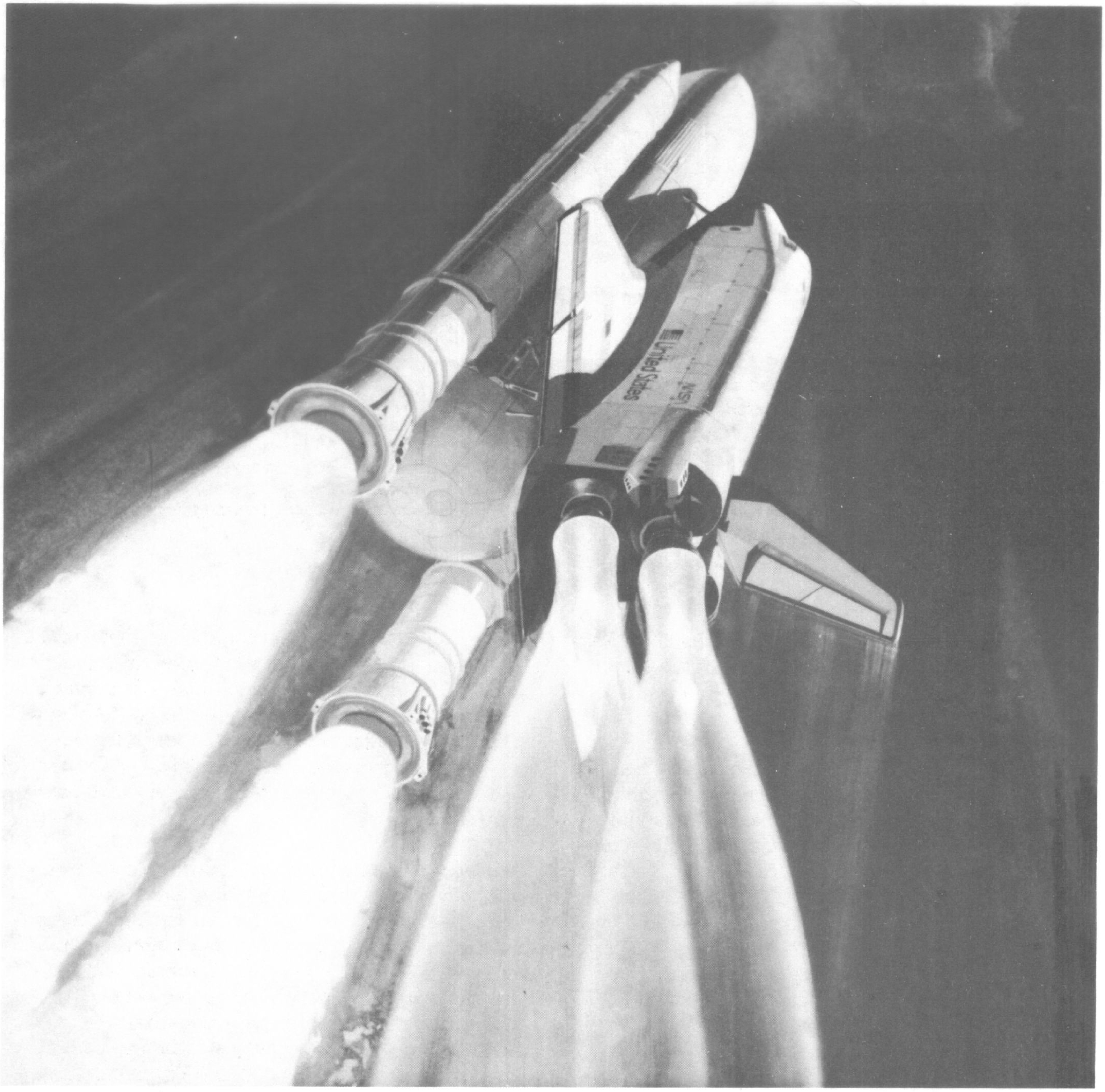
The Shuttle Era



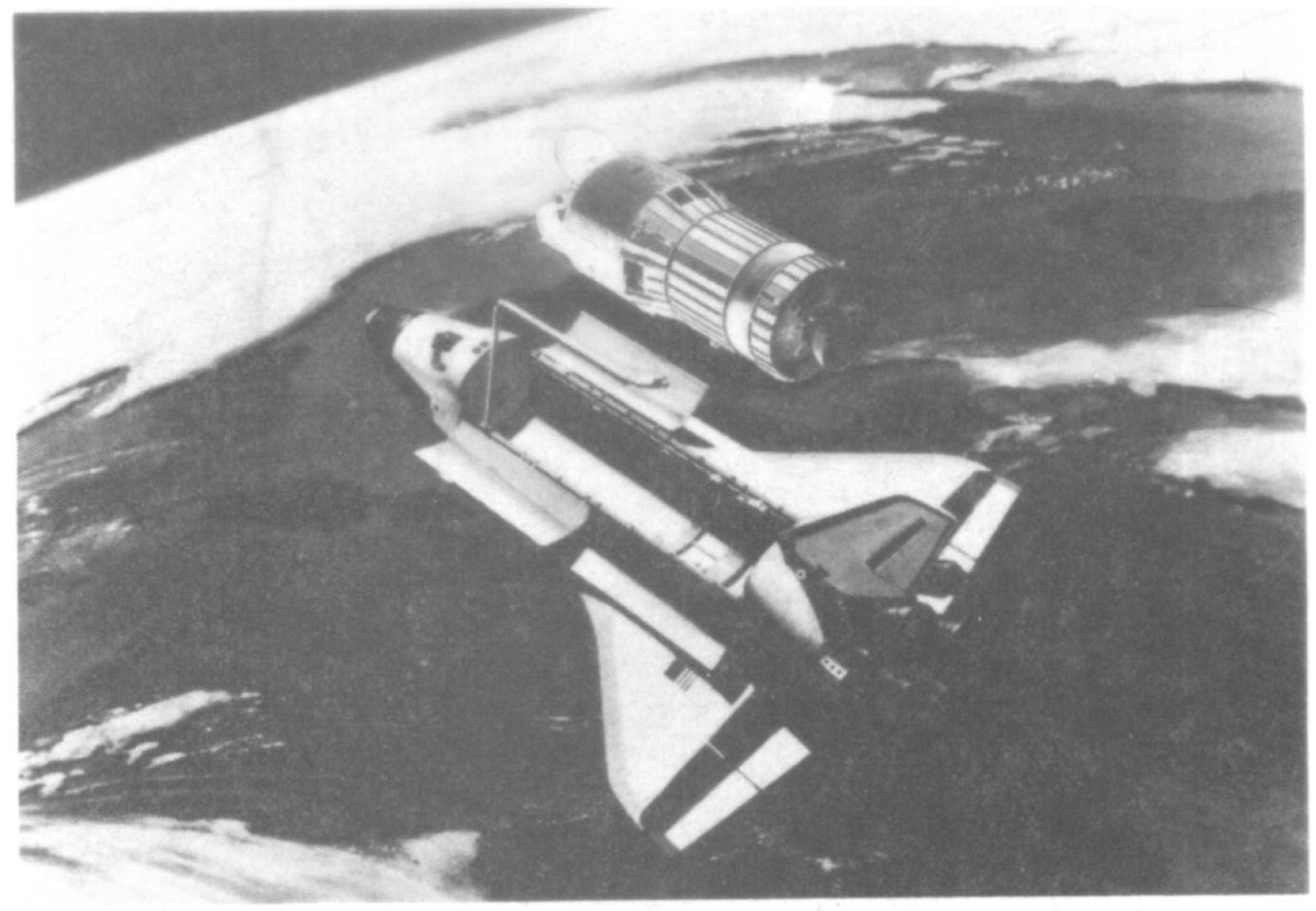


The Space Shuttle launch vehicle, with the Orbiter attached to the external tank and a pair of solid rocket boosters, climbs upward to begin its route to Earth orbit (artist's concept). This is a low-angle view indicating that the solid rocket boosters will soon be jettisoned. The external tank will also be jettisoned before the Orbiter enters an Earth-orbital configuration.

Cover

A unique high-angle view of the Space Shuttle (artist's concept). The Orbiter, still attached to the external tank as the solid rocket boosters are jettisoned, climbs upward to begin its Earth orbital mission.

The Shuttle Era

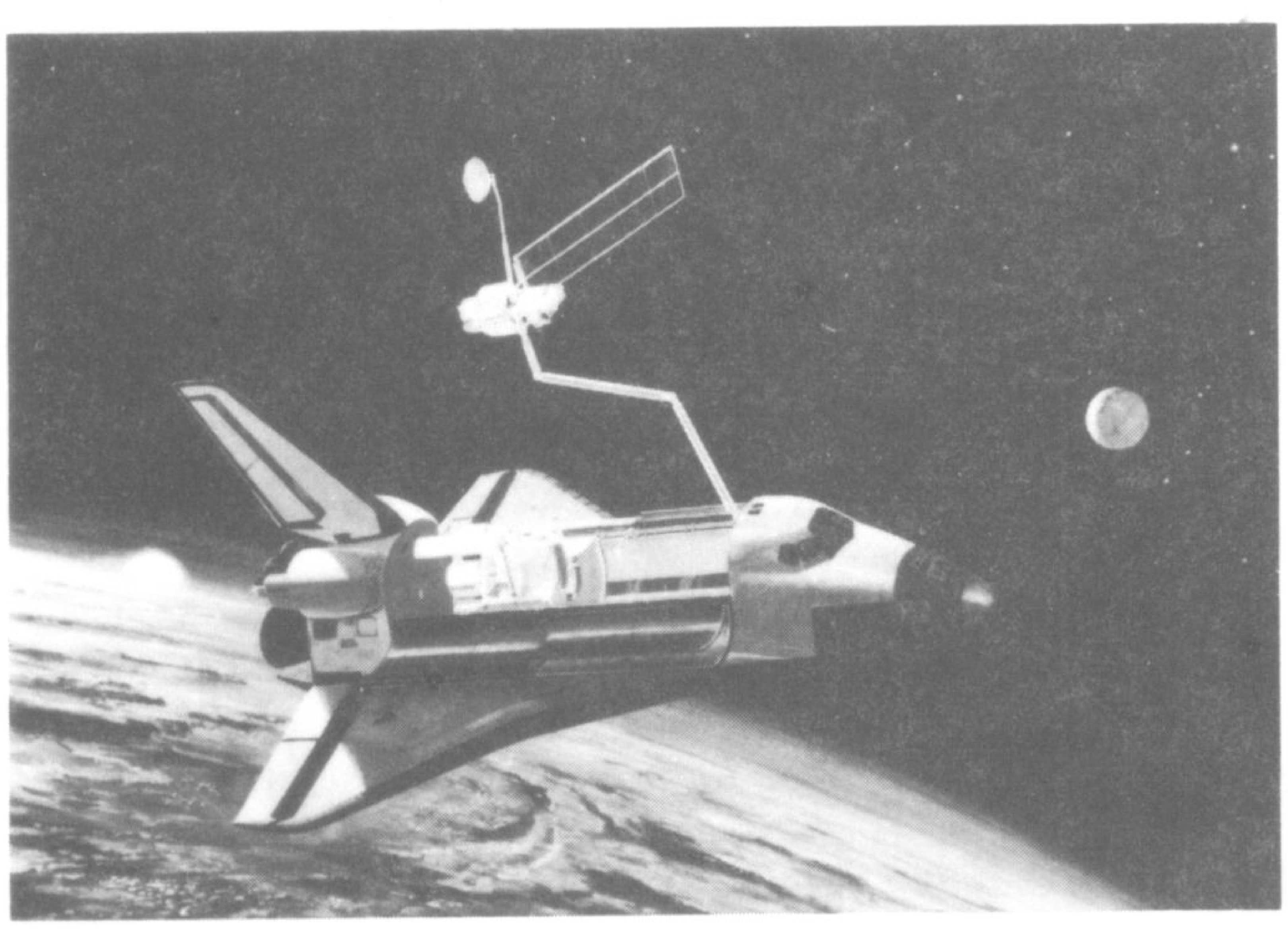


The Inertial Upper Stage (IUS) is deployed from open payload bay of Shuttle Orbiter into space by the Orbiter's remote manipulator (artist's concept). The IUS can rocket spacecraft to geosynchronous orbits or into interplanetary trajectories. The IUS is one of two expendable, low-cost propulsion vehicles that are being considered for the Space Transportation System.

On December 17, 1903, Orville and Wilbur Wright successfully achieved sustained flight in a power-driven aircraft. The first flight that day lasted only 12 seconds over a distance of 37 meters (120 feet), which is about the length of the Space Shuttle Orbiter. The fourth and final flight of the day traveled 260 meters (852 feet) in 59 seconds. The initial notification of this event to the world was a telegram to the Wrights' father.

Sixty-six years later, a man first stepped on the lunar surface and an estimated 500 million people around the world watched the event on television or listened to it on radio as it happened.

Building upon previous achievements, new plateaus in air and space transportation have been reached —military aviation, airmail, commercial passenger service, the jet age, and manned space flight. Now a new era nears. The beginning of regularly scheduled runs of NASA's Space Shuttle to and from Earth orbit in the 1980's marks the coming of age in space. The Shuttle turns formidable and costly space missions into routine and economical operations that generate maximum benefits for all people. Shuttle opens space to men and women of all nations who are reasonably healthy and have important work to do there.



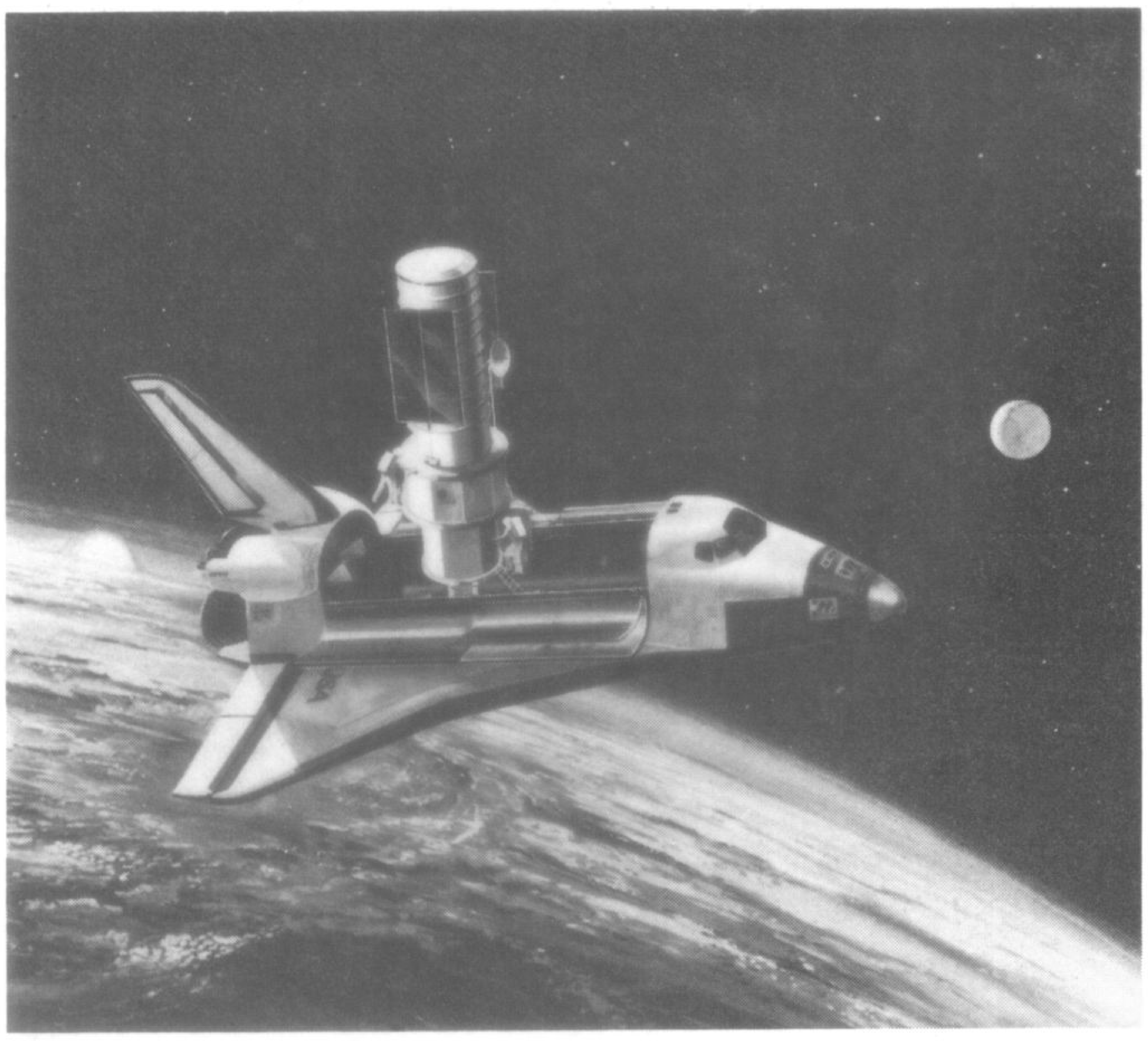
A Versatile Vehicle

Space Shuttle is a true aerospace vehicle. It takes off like a rocket, maneuvers in Earth orbit like a spacecraft, and lands like an airplane. The Space Shuttle is designed to carry heavy loads into Earth orbit. Other launch vehicles have done this. But unlike the other launch vehicles which were used just once, each Space Shuttle Orbiter may be used again and again.

Moreover, Shuttle permits checkout and repair of unmanned satellites in orbit, or return of the satellites to Earth for repairs that could not be done in space. This will result in considerable savings in spacecraft costs. Satellites that the Shuttle can orbit and maintain include those involved in environmental protection, energy, weather forecasting, navigation, fishing, farming, mapping, oceanography, and many other fields useful to man.

Spacecraft destined for geosynchronous orbit will be boosted from low Earth orbit by either a Solid Spinning Upper Stage (SSUS) or by the Inertial Upper Stage (IUS) that is being developed by the United States Air Force. Interplanetary spacecraft will be propelled by a variation of the Centaur upper stage that has been used with the Atlas and Titan expendable launch vehicles.

With its manipulator arm extended, the Space Shuttle Orbiter prepares to retrieve a satellite (artist's concept).



The large Space Telescope is being designed as an optical telescope observatory to be used in Earth orbit, unhindered by atmospheric distortion. Here, it is shown being deployed in orbit by the Space Shuttle.

Unmanned satellites, such as the Space Telescope, which can multiply our view of the universe, and the Long Duration Exposure Facility (LDEF), which can demonstrate the effects on materials of long exposure to the space environment, can be placed in orbit, erected, and returned to Earth by the Space Shuttle. Shuttle crews can also perform such services as replacing the Space Telescope's film packs and lenses. The Space Telescope program is managed by NASA's Marshall Space Flight Center, Huntsville, Alabama and the LDEF is a project of the NASA Langley Research Center, Hampton, Virginia.

The Shuttle is a manned spacecraft, but unlike manned spacecraft of the past such as Mercury, Gemini, and Apollo, it touches down like an airplane on a landing strip. Thus, the Shuttle eliminates the need for the expensive sea recovery force required for Mercury, Gemini, and Apollo. In addition, unlike the previous manned spacecraft, the Shuttle is reusable. It can be refurbished and ready for another journey into space in a comparatively short turnaround time.

The Shuttle can quickly provide a vantage point in space for observations of transient astronomical events or of sudden weather, agricultural, or environmental crises. Information from Shuttle observations could contribute to sound decisions for countries dealing with such problems.

The Shuttle is scheduled to carry a complete scientific laboratory called "Spacelab" into Earth orbit. Developed by the European Space Agency (ESA), Spacelab is similar to earthbound laboratories but is adapted to operate in zero gravity (weightlessness). It provides a shirt-sleeve environment, suitable for working, eating, and sleeping without the encumbrance of special clothing or space suits.

Spacelab provides facilities for as many as four laboratory specialists to conduct experiments in such fields as medicine, manufacturing, astronomy, and pharmaceuticals. Spacelab remains attached to the Shuttle Orbiter throughout a mission. Upon return to Earth, Spacelab is removed from the Orbiter and outfitted for its next assignment. It can be reused about 50 times.

Spacelab personnel will be men and women of many nations, experts in their fields, and in reasonably good health. They will require only a few weeks of space-flight training.

Participating ESA nations are Belgium, Denmark, France, Italy, The Netherlands, Spain, Switzerland, United Kingdom, Austria, and the Federal Republic of Germany (West Germany). Spacelab is an example of international sharing of space costs and of worldwide interest in the study of science in a space environment.

Projects that only recently were considered impracticable become feasible with Space Shuttle. Shuttle can carry into orbit the building blocks for large solar power stations that would convert the abundant solar heat and sunlight of space into unlimited supplies of electricity for an energy-hungry world. These building blocks would be assembled by specialists, transported, and supported by Space Shuttle.

The Shuttle can also carry the building blocks for self-sustaining settlements into Earth orbit. Inhabitants of these settlements could be employed in such vital occupations as building and maintaining solar power stations and manufacturing drugs, metals, glass for lenses, and electronic crystals. Manufacturing in weightless space could reduce costs of certain drugs, create new alloys, produce drugs and lenses of unusual purity, and enable crystals to grow very large. Drugs, metals, glass, and electronic crystals will also be manufactured during Spacelab missions, long before the establishment of any space settlement.

Space Shuttle System and Mission Profile (Principal Components)

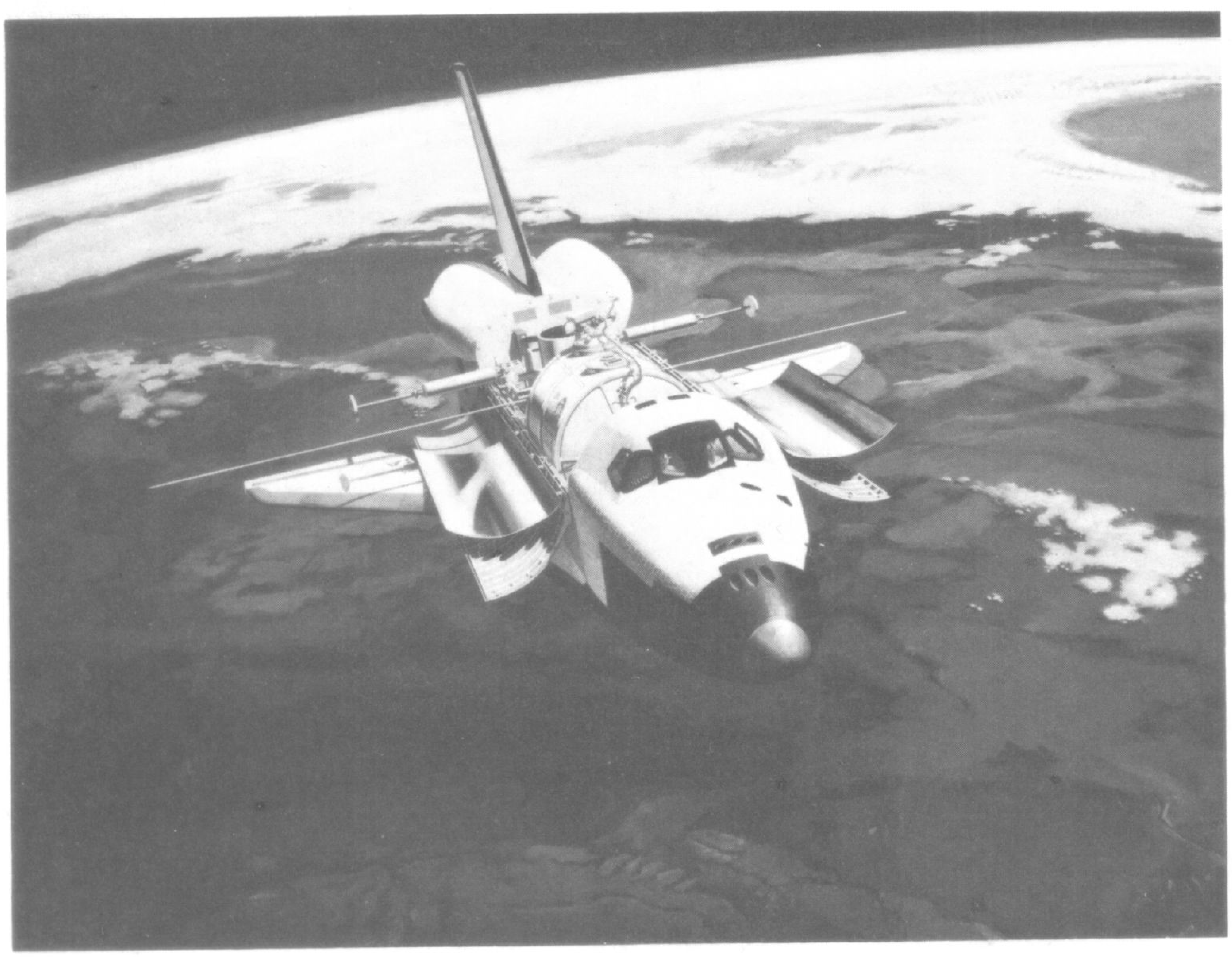
The Space Shuttle flight system is composed of the Orbiter, an external tank (ET) that contains the ascent propellant to be used by the Orbiter main engines, and two solid rocket boosters (SRB's). Each booster rocket has a sea level thrust of 11.8 million newtons (2.65 million pounds). The Orbiter and the SRB's are reusable; the external tank is expended on each launch.

The Orbiter is the crew and payload carrying unit of the Shuttle system. It is 37 meters (122 feet) long and 17 meters (57 feet) high, has a wingspan of 24 meters (78 feet), and weighs about 68 000 kilograms (150 000 pounds) without fuel. It is about the size and weight of a DC-9 commercial air transport.

The direction of Earth rotation has a significant bearing on the payload launch capabilities of the Shuttle. A due east launch from the Kennedy Space Center in Florida, using the Earth's easterly rotation as a launch assist, will permit a payload of up to 29 500 kilograms (65 000 pounds) to be carried into orbit. A polar orbit launch from Vandenberg Air Force Base in California, where the Earth's rotation neither assists nor hinders the Shuttle's capabilities, will permit a payload of up to 18 000 kilograms (40 000 pounds) to be carried into orbit. The most westerly launch from Vandenberg will allow a payload up to only 14 500 kilograms (32 000 pounds) to be transported to orbit since the Earth's rotation is counter to the westerly launch azimuth. The Orbiter carries its cargo in a cavernous payload bay 18.3 meters (60 feet) long and 4.6 meters (15 feet) in diameter. The bay is flexible enough to provide accommodations for unmanned spacecraft in a variety of shapes and for fully equipped scientific laboratories.

Each of the Orbiter's three main liquid-rocket engines has a thrust of 2.1 million newtons (470 000 pounds) at sea level. They are fed propellants from the external tank, which is 47 meters (154 feet) long and 8.7 meters (28.6 feet) in diameter.

At lift-off the tank holds 720 000 kilograms (1 580 000 pounds) of propellants, consisting of liquid hydrogen (fuel) and liquid oxygen (oxidizer). The hydrogen and oxygen are in separate pressurized compartments of the tank. The external tank is the only part of the Shuttle system that is not reusable.



A high-angle front view of the Orbiter vehicle in Earth orbit carrying Spacelab hardware as the primary cargo in its payload bay (artist's concept).
A crewmember is seen performing extravehicular operations outside the pressurized laboratory in the payload bay.

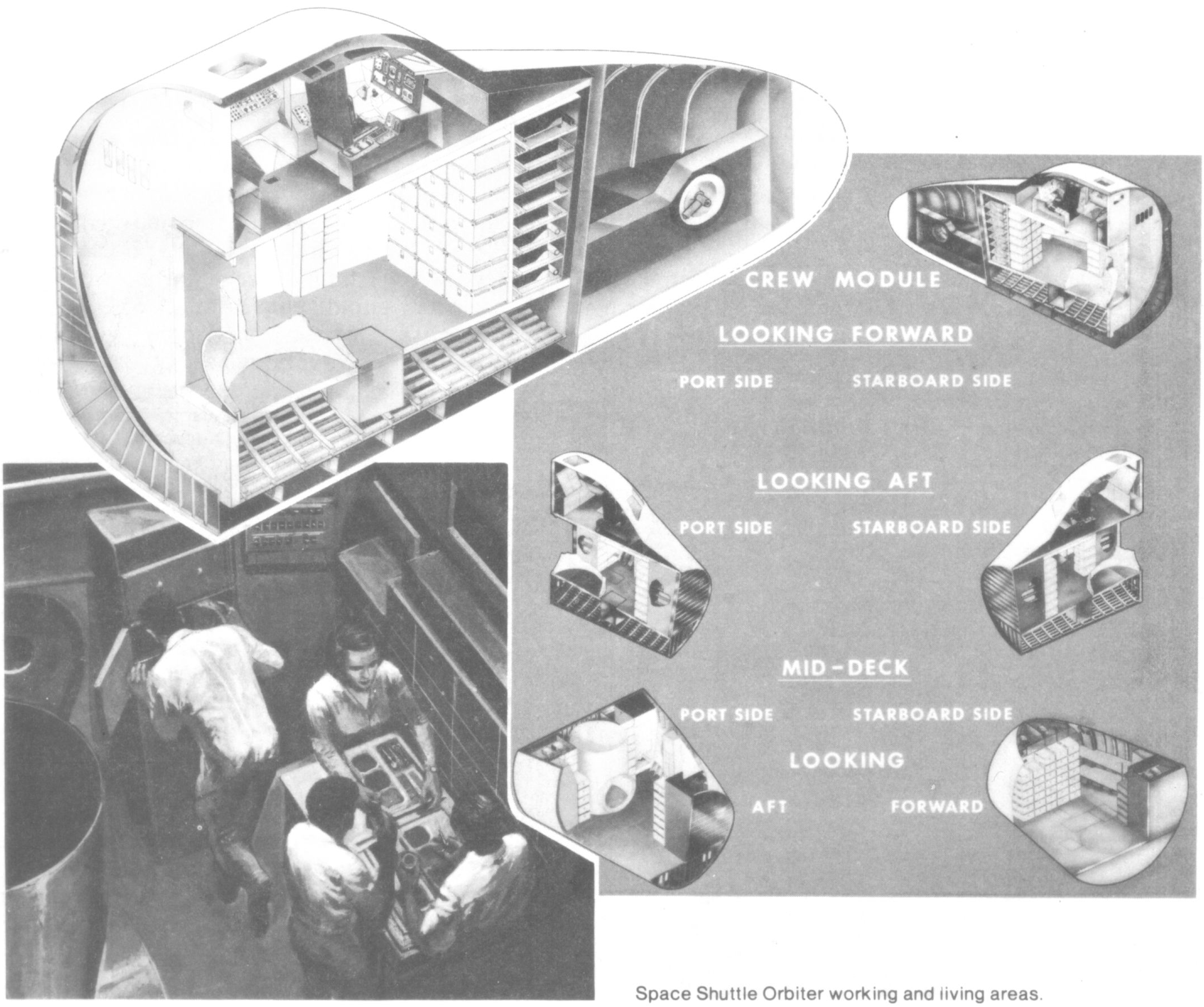
Crew and Passenger Accommodations

The crew and passengers occupy a two-level cabin at the forward end of the Orbiter. The crew controls the launch, orbital maneuvering, atmospheric entry, and landing phases of the mission from the upper-level flight deck. Payload handling is accomplished by crewmen at the aft cabin payload station. Seating for passengers and a living area are provided on the lower deck. The cabin will have maximum utility; mission flexibility is achieved with minimal volume, complexity, and weight. Space flight will no longer be limited to intensively trained, physically perfect astronauts but will now accommodate experienced scientists and technicians.

Crewmembers and passengers will experience a designed maximum gravity load of only 3g during launch and less than 1.5g during a typical reentry. These accelerations are about one-third the levels experienced on previous manned flights. Many other features of the Space Shuttle, such as a standard sea level atmosphere, will welcome the nonastronaut space worker of the future.

Typical Shuttle Mission

The Space Shuttle mission begins with the installation of the mission payload into the Orbiter payload bay. The payload will be checked and serviced before installation and will be activated on orbit. Flight safety items for some payloads will be monitored by a caution and warning system.

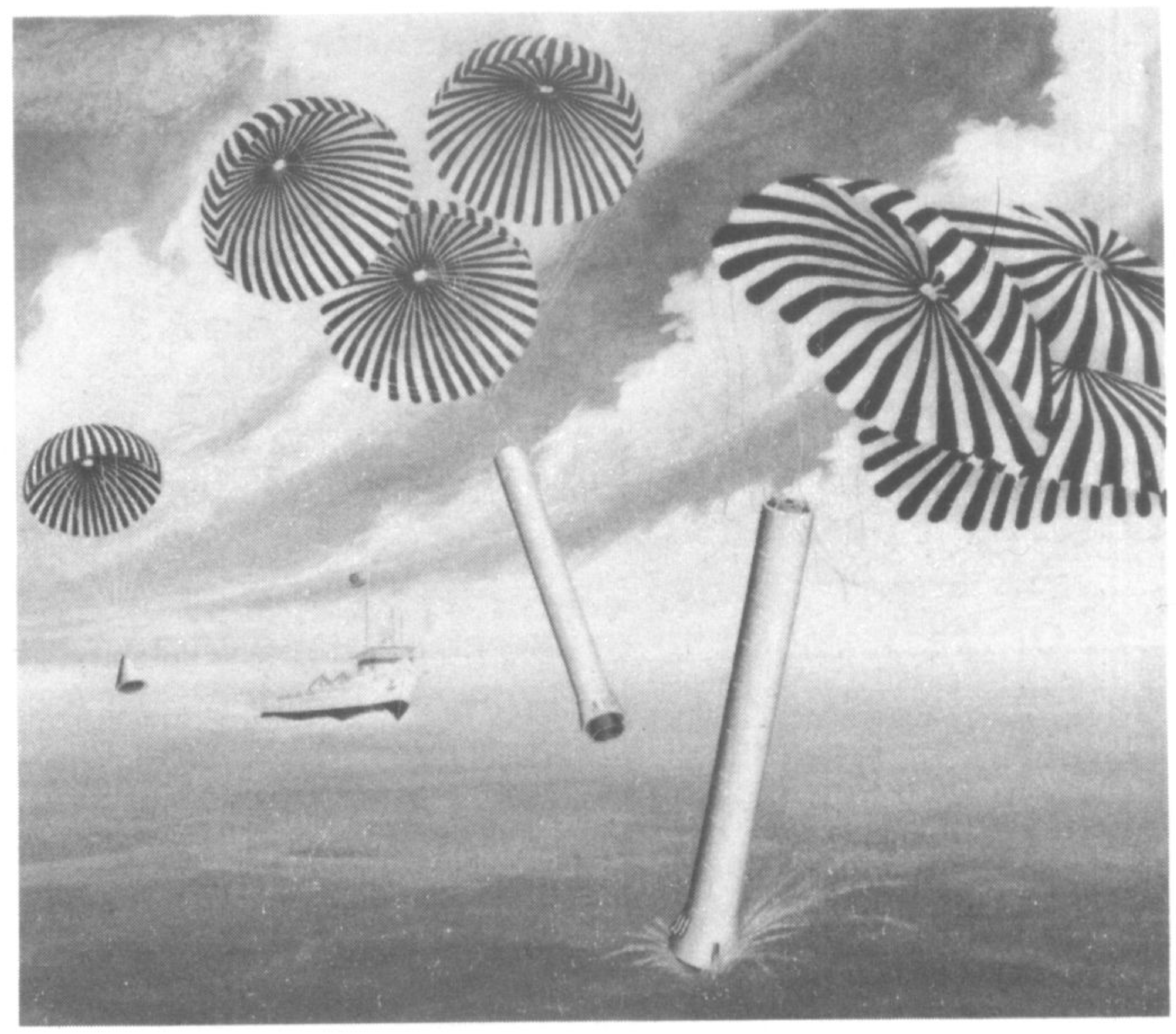


Space Shuttle Orbiter working and living areas.

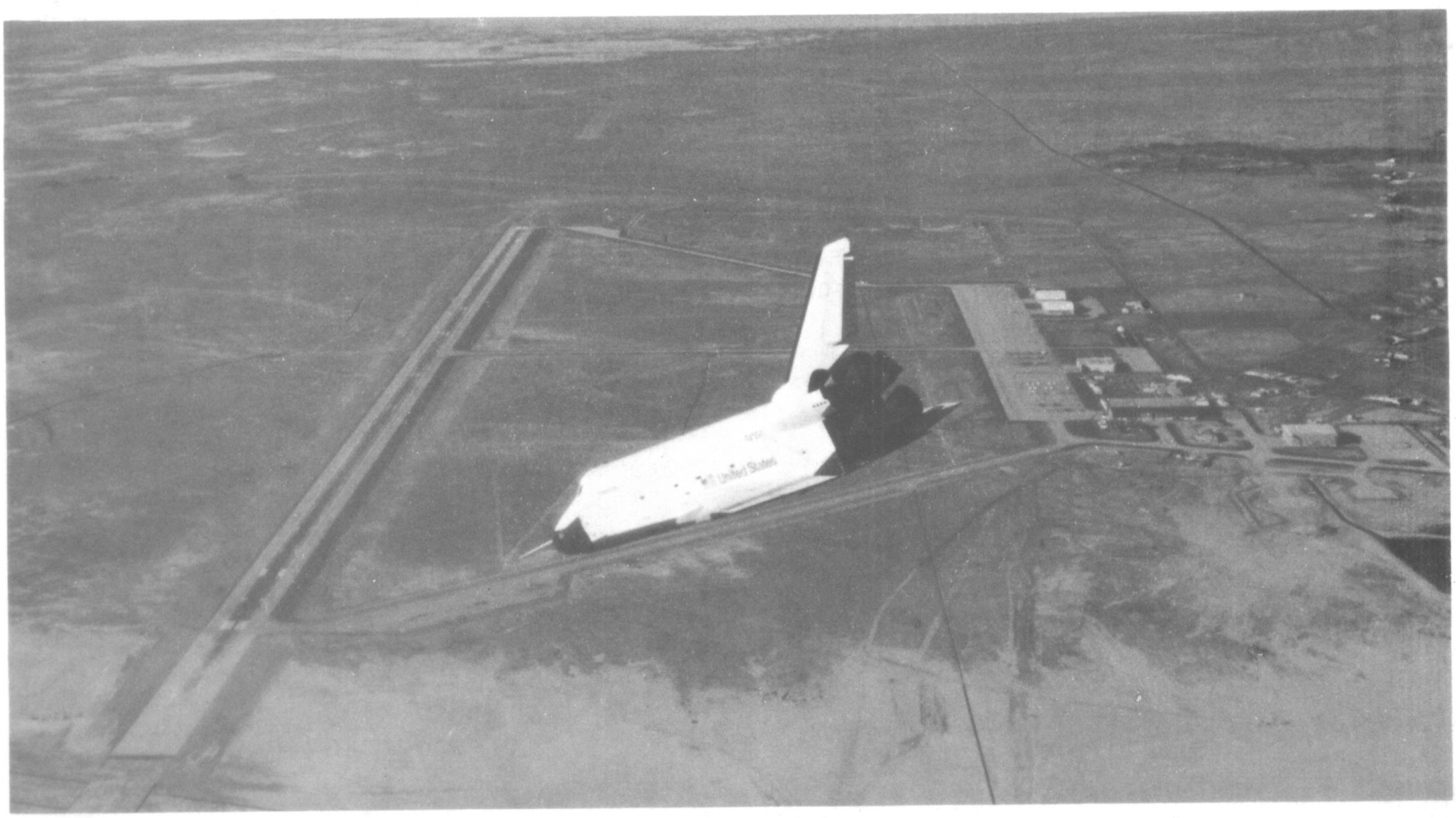
In a typical Shuttle mission, which lasts from 7 to 30 days, the Orbiter's main engines and the booster ignite simultaneously to rocket the Shuttle from the launch pad. Launches are from the John F. Kennedy Space Center in Florida for east-west orbits or from Vandenberg Air Force Base in California for polar or north-south orbits.

At a predetermined point, the two unmanned solid rocket boosters separate from the Orbiter and parachute to the sea where they are recovered for reuse. The Orbiter continues into space. It jettisons its external propellant tank just before orbiting. The external tank enters the atmosphere and breaks up over a remote ocean area.

In orbit, the Orbiter uses its orbital maneuvering subsystem (OMS) to adjust its path, for rendezvous operations, and, at the end of its mission, for slowing down so as to head back toward Earth. The orbital speed is nearly 8000 meters per second (18000 miles per hour). It takes approximately 90 minutes for an orbit of the Earth by the Space Shuttle, whether launched from NASA's Kennedy Space Center or, for some later flights, from Vandenberg Air Force Base in California. The first four orbital flight tests will be launched from Pad 39 at the Kennedy Space Center and land at Edwards Air Force Base, California



Solid rocket boosters landing at sea, where they will be picked up for reuse.



Facilities on a part of the huge Edwards Air Force Base in the desertland of Southern California form the backdrop for the Shuttle Orbiter 101 "Enterprise" as it heads for a landing during the fourth Approach and Landing Test (ALT) free flight. Note that the tail cone is removed from the Enterprise for this flight, which featured a 2-minute 34-second unpowered phase after the Orbiter separated from NASA 905, a 747 carrier aircraft. Crewmen for the flight were Astronauts Joe H. Engle, commander, and Richard H. Truly, pilot.

The OMS propellants are monomethyl hydrazine as the fuel and nitrogen tetroxide as the oxidizer. They ignite on contact, eliminating the need for ignition devices.

The Orbiter does not necessarily follow a ballistic path to the ground as did predecessor manned spacecraft. It has a crossrange capability (can maneuver to the right or left of its entry path) of about 2045 kilometers (1270 miles).

The Orbiter touches down like an airplane on a runway at Kennedy Space Center or Vandenberg Air Force Base. Landing speed is about 341 to 364 kilometers per hour (212 to 226 miles per hour). After refurbishing, the Shuttle is ready for another space mission.

Space Shuttle Vehicle Crew

The Shuttle crew can include as many as seven people: the commander, the pilot, the mission specialist who is responsible for management of Shuttle equipment and resources supporting payloads during the flight, and one to four payload specialists who are in charge of specific payload equipment. The commander, pilot, and mission specialist are NASA astronauts. Payload specialists conduct the experiments and may or may not be astronauts. They are nominated by the payload sponsor and certified for flight by NASA.

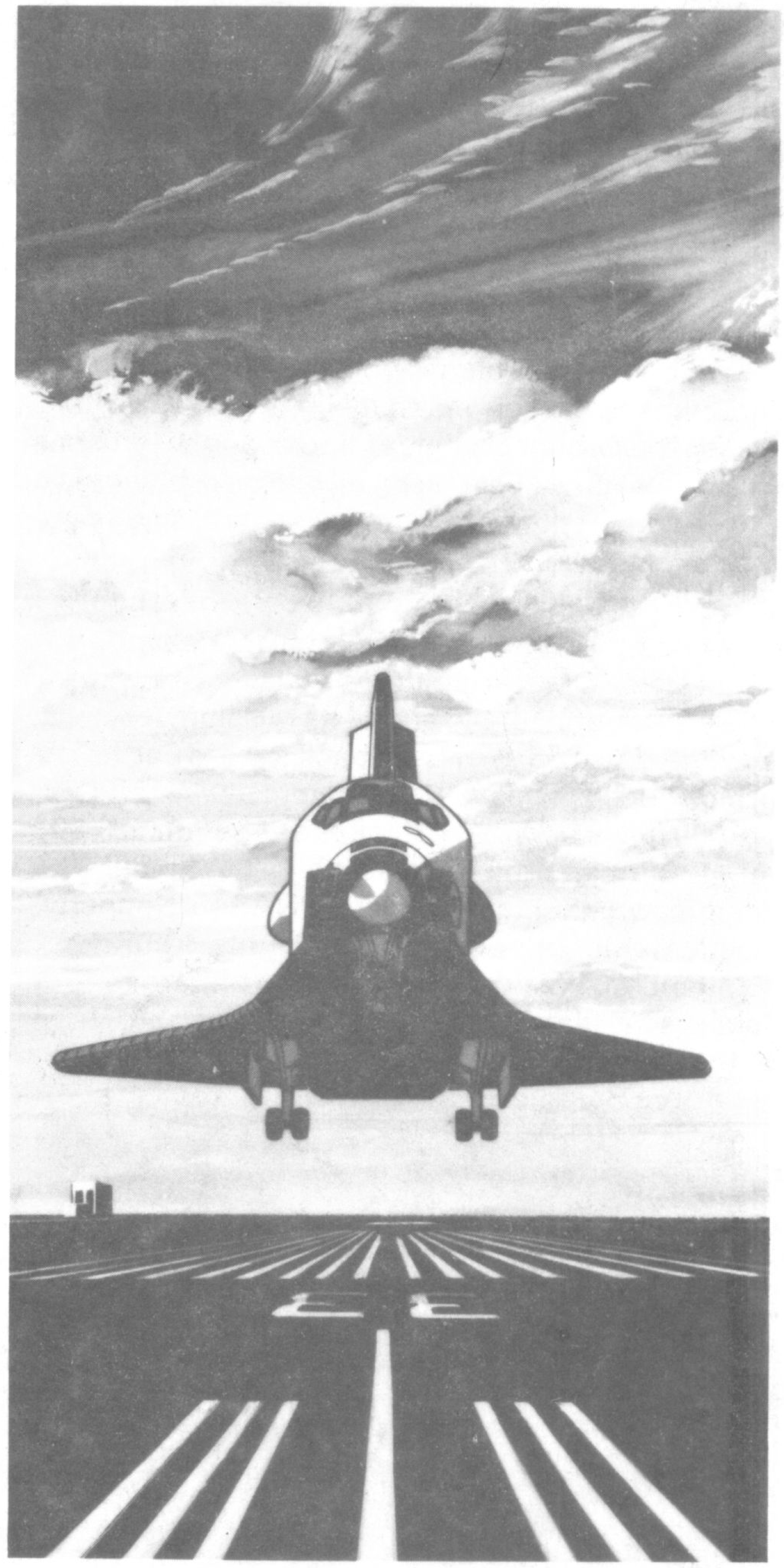
Shuttle Management Team

NASA's Lyndon B. Johnson Space Center, Houston, Texas, manages the Space Shuttle program and is also responsible for development, production, and delivery of the Orbiter.

NASA's George C. Marshall Space Flight Center, Huntsville, Alabama, is responsible for the development, production, and delivery of the solid rocket boosters, the external propellant tank, and the Orbiter main engines. Test firings of Shuttle engines are carried out at NASA's National Space Technology Laboratories, Bay St. Louis, Mississippi.

NASA's John F. Kennedy Space Center, Florida, is responsible for design and development of launch and recovery facilities and for operational missions requiring easterly launches.

Thousands of companies make up the Shuttle contractor team. They are located in nearly every state of the United States.



A head-on view of a Space Shuttle Orbiter landing at the Kennedy Space Center (artist's concept). The huge vehicle assembly building (VAB) is shown in the background.

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